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Statement by

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Introduction

Mr. Chairman, Members of the House National Security Subcommittee on Military Research and Development. I am very honored to have been invited here today on behalf of the Director of the Defense Advanced Research Projects Agency (DARPA), Mr. Larry Lynn, to explain the Agency's approach and strategies, to discuss our FY 1998 plans, and to brief you on some of our recent accomplishments.

For those of you who are new to the Committee, let me take a moment to review DARPA's mission and role. DARPA is the central research and development organization of the Department of Defense. Its primary responsibility is to maintain US technological superiority over potential adversaries. In doing so, we complement, without competition or duplication, the work of the research and development (R&D) organizations specific to the Military Departments. We are an integral part of the DoD Science and Technology (S&T) Strategy process of the Director, Defense Research and Engineering, and we contribute heavily to the Joint Warfighting S&T Plan, the Defense Technology Area Plan, and the Basic Research Plan.

In practice, DARPA's most prominent role is to invest in the highest-payoff technologies and military concepts — even when technical risk would inhibit others. DARPA is uniquely idea-driven and project-oriented, in contrast to other agencies that are driven by formalized requirements and oriented around programmed investments. Where action is required, DARPA can move very quickly. Where sustained investment in areas of critical development is required, DARPA can be very patient. And in the post Cold-War era where the Department has an overwhelming need for affordability, DARPA can be very business-like. DARPA is an agency characterized by change and responsiveness to the warfighter at all levels.

DARPA: The Agency

DARPA is a small organization with a tradition of deliberate entrepreneurship and risk-taking necessary to achieve high payoff goals. It is typically free of the self-imposed constraints that most organizations develop because of its constant change in personnel and projects. The key ingredients that have been proven over time to maintain this character are: (1) remaining small and flexible, (2) carefully selecting and managing projects and, (3) assuring that DARPA is populated with the best technical people this country can provide.

While referring to the first of these ingredients last year, Director Lynn described to you adjustments made in the Agency's budgets and staff size. He has streamlined the organization to fit his current vision of the most pressing goals and objectives. In addition, he has re-emphasized the long-standing policy of rotation of our technical personnel to assure a constant influx of new ideas and new talent with recent industry or laboratory experience.

The second key ingredient, program selection and management, is a constantly changing process. Typically, DARPA turns over programs on about a 3- to 4-year cycle. We go into an area, get it started, and then transfer the efforts to the Military Departments to exploit it in ways suitable to meet their needs. This strategy will be illustrated over and over in the next few sections.

The third key ingredient, DARPA's people, is elementary to everything else. We are only as effective as our people are. DARPA has been able to recruit some outstanding talent from industry as new Program Managers, but it has been difficult. The salaries we can offer top scientists and engineers are not enough of an incentive to come work for the Agency. In addition, the time it takes our ponderous civil service system to hire an expert from industry makes it difficult for DARPA to get into, and out of, technical areas as quickly as technology sometimes warrants.

By contrast, the availability of the provisions of the Intergovernmental Personnel Act make it much easier to detail experts into DARPA from universities, nonprofit organizations, and state and local governments. We do, however, need to be well-rounded and include as DARPA Program Managers those with experience in industrial and research organizations. An arrangement within DoD's personnel system that would permit similar details from such industrial organizations would be beneficial.

The Character of DARPA's Strategy

The character of DARPA's strategy can be described by three central elements:

- High-payoff, high-risk: First, we concentrate on high-payoff technologies and military concepts while being tolerant of high risk. We can move quickly into and out of technical areas because DARPA has no institutionalized laboratories, facilities, or organizations. Our projects have limited life-spans, and we continually review our investments and terminate those efforts where payoff does not meet our high expectations.

- Long-term development: Second, in seeming contradiction, we must sometimes invest in those critical military technology developments that require an extended focus and long-term development. These are the important, but technically tough problems. For instance, the possibility that technology could enable radar systems to automatically classify targets would make a major difference to our warfighters. Automatic Target Recognition for many years was "too-hard-to-do" for all but DARPA. Recently, however, the many years of research have started to pay off.

- Expedited warfighter technology applications: Third, we focus on new military capabilities and solutions to critical military problems. We interact frequently with the Unified Commanders and Joint Staff so that we can converge near-term technologies into military weapon systems that can be provided to the joint warfighter for an early evaluation. In many cases, these are Advanced Concept Technology Demonstrations (ACTDs). The ACTD approach permits direct warfighter participation in developing technologies, coupled with changes in concepts of operation and tactics, providing rapid feedback in the development process.

DARPA is the only development organization with a specific Joint charter. We work very hard to blend together the common technological needs of the Service warfighting components with the objectives of the Joint Staff. To enhance connections with our ultimate customer, the warfighter, DARPA has brought two senior military officers into the Agency to serve as principal points of contact for our interaction with the various CINCs, Joint Staff, and Services. These individuals work closely with the operational user to ensure technological needs are met. At the same time, they work across the Agency to ensure that our technologists take a "customer view" of their programs. They are, in essence, the warfighters' advocates within the Agency.

DARPA's innovation is not limited to technology. We have pioneered many innovative contracting and management approaches and maintain a routine intimacy with the commercial sector. These two together have helped us leverage commercial technology to provide both affordability and increased performance, as well as moving advanced capabilities into the hands of warfighters more quickly. This kind of innovation is critical if the Department is to stay at the cutting edge in efforts to change the way it conducts business.

Military Environment

DARPA's priorities are driven by assumptions about the future nature of conflicts. Therefore, I'd like to outline our view of the future military environment before I detail our key military and technology activities for FY 1998.

Joint Vision 2010 was recently released by the Joint Staff as a conceptual template for achieving new levels of joint warfighting effectiveness. This vision forecasts dynamic change in the nature of potential adversaries, emphasizes the increasingly critical nature of technological advances and their implications, and outlines the emerging importance of information superiority.

The US military of the next few decades will face new threats. While the Soviet Union has disappeared, there will continue to be states or groups that oppose or threaten American interests and values — or those of our friends and allies. And they will almost certainly depend on unconventional means, such as weapons of mass destruction (e.g., biological and chemical attack), cruise missiles, and information war to substitute for military mass. Crises dominated by smaller but equally dangerous operations ranging from guerrilla war to terrorism are more numerous than before.

Joint Vision 2010 goes on to point out that "our most vexing future adversary may be one who can use technology to make rapid improvements in its military capabilities that provide asymmetrical counters to US military strengths, including information technologies." With our adversaries exploiting US vulnerabilities, the Vision anticipates "the probability of facing technological or operational surprise will increase in the period ahead." I would add that the increasing worldwide arms market enables purchase of weaponry comparable to US systems, and with which our own military capabilities may be readily countered.

Joint Vision's characterization of the future military environment is sobering: ". . . the US must prepare to face a wider range of threats, emerging unpredictably, employing varying combinations of technology, and challenging us at varying levels of intensity."

What does technology have to offer in this new environment?

We must now selectively develop technologies that maximize the effectiveness of our Nation's aging major weapons systems, "outrun" the capabilities available on the open market, maximize the capability of a smaller force of warfighters so that only a minimum number of personnel must be exposed to harm, and enable all weapons systems to have the flexibility necessary to respond to the full range of future conflicts.

Information technology — its collection, assimilation, dissemination, comprehensiveness, timeliness, survivability, integrity, and reliability — is pervasive in satisfying almost all of these needs. The military that stays ahead in information is likely to dominate in the future. Behind information technology, of course, are the microelectronics and materials science that makes the enormous advances in this area possible. Together, these are the basis of much of the future capabilities in military systems. As I talk further about DARPA's strategies and programs, you will see that information underlies a majority of our investments.

We pursue solutions to military needs from two perspectives. First, in what we call "Military Pull," we work closely with the warfighting community to try to anticipate military problems and capabilities where advanced technology can make a difference, even before a formal "requirement" is recognized. We then create a vision of what we believe could be done in 10 to 20 years to solve the problem and define the technology development that must be pursued to make the vision a reality. Stealth is now a well-known example.

Sometimes such long-range vision is not required. When Director Lynn testified before you last year, he spoke of the Bosnia Communications and Control Augmentation ("BC2A") system. BC2A is an example of DARPA's leadership in supporting joint and coalition operations in the near-term. Initiated in January 1996, BC2A has become the first-ever direct broadcast (30 Mbps one-way) and distributed collaboration (6 Mbps full duplex) satellite communications and information system in Europe to support Operation Joint Endeavor at the Secret/NATO level of classification. Using high bandwidth, commercial satellite equipment and advanced information tools (Netscape), 29 locations in the theater support the real-time distribution of video produced by the Predator Unmanned Air Vehicle (UAV), as well as P-3 and Airborne Reconnaissance Low. The network also handles imagery, maps and other operational information. For the first time, information producers are "on-line" with the users, who can access information servers throughout the continental United States. After only 11 months, day-to-day operations of the BC2A program have been transferred to the Defense Information Systems Agency (DISA).

Second, in classic "Technology Push," we identify technologies that could make a difference, and we work to understand the limits and capabilities of those technologies and to translate them into military applications.

Take, for example, automated speech technology. Computers that can respond to spoken commands have been a long-term DARPA investment area. Now, success is nearly at hand: a DARPA-developed hand-held computer has been demonstrated in real-time language translation in Bosnia. From a spoken English phrase, the computer responds through a loudspeaker with the equivalent Serbo-Croatian translation. Even now, the system is being tested by military police, border crossing guards, and others who come into contact with the local population. A more sophisticated version of this computer is being used by military field intelligence units to gather information from civilians in the field and wirelessly transmit this information back to headquarters. Ten more experimental units are headed for Bosnia this month.

Our investments divide roughly equally between these two fundamental motivations, Military Pull and Technology Push. In addition, we take a cross-cutting approach to affordability, a universal problem across the military systems. While we undertake a few programs which directly address affordability, it is most often a component of our thinking spread across most development efforts. And we do not depend solely on the expertise and understanding of our own staff. Many of our best ideas come from industry, civilian and government laboratories, and academia. We routinely solicit guidance from specialized groups that we charter in materials, devices and information sciences, and we seek advice from important organizations such as the Defense Science Board and the Jasons.

Military Pull

Joint Vision 2010 describes a vision of future warfighting based on four operational concept objectives: Dominant Maneuver, Precision Engagement, Full Dimensional Protection, and Focused Logistics. I would like to explain in some detail how our activities, current and future, support this vision.

I. Dominant Maneuver

Dominant Maneuver is the positioning and employment of widely dispersed, Joint air, land, sea, and space forces to accomplish the assigned operational tasks. DARPA projects support this concept in all domains.

Unlike the mass-on-mass engagements of the past, land warfare in the future will be much more distributed. DARPA is managing a coherent set of projects that will enable very small, very dispersed units to out-perform the warfighting operations of much larger, massed forces. Called

Small Unit Operations (SUO), these have exciting potential for the modern force. SUO is an unusual example of the typically conservative infantryman of the Army and Marine Corps pushing current technology with fundamentally new concepts of operation.

DARPA's role is to provide these dispersed units with advanced sensor systems, robust, wireless communications and precision geolocation, especially in restrictive environments (e.g., urban, highly mountainous, heavily forested). We believe that the capability for real-time precision targeting and surveillance information from internetted and arrayed sensors will free the individual soldier for independent, yet coordinated, action.

DARPA has recently demonstrated prototype mine and sniper detection systems in coordination with the Army, as well as a rudimentary situation awareness capability at the Marine Corps' Hunter Warrior exercise. We are now evaluating alternative architectures for this system and have awarded contracts for several sensor technologies. During FY 1998, DARPA will continue to field experiments to test emerging technologies and new concepts of operation which support Sea Dragon, Force XXI, and Army After Next concepts. These will include robotics, tactical deception technologies, and precision logistics.

A. Unmanned or Minimally Manned Warfare.

For use high above the battlefield, the High Altitude Endurance Unmanned Air Vehicle (HAE UAV) Program is developing and demonstrating high-altitude, long-endurance unmanned air vehicle systems capable of wide-area surveillance with high-resolution sensors. The HAE UAV is an advanced airborne reconnaissance system comprised of two complementary air platforms. The Tier II Plus Global Hawk is optimized for supporting low-to-moderate threat, long-endurance surveillance missions in which range, endurance and persistent coverage are paramount. The Tier III Minus DarkStar features low-observable technology and is optimized for a moderate-endurance, high-altitude reconnaissance mission in which ensured, survivable coverage is more important than range and endurance.

While not funded by the DARPA budget, the program is managed by DARPA for the Defense Airborne Reconnaissance Office in a joint program office which includes the Army, Navy and Air Force. Each vehicle is specified to have a unit flyaway price of no more than $10 million (in FY 1994 dollars), averaged over production vehicles number 11 to number 20.

The Arsenal Ship is one of our highest priority Navy programs. It is being developed to directly support joint commanders in the future regional land battle. The general concept is to provide direct fire support from a remote platform at sea for a variety of missions without the logistics burden of transporting both delivery systems and ammunition to the shore and the forward areas. As a complement to the SUO concept, this ship is being designed to be highly survivable, while carrying large quantities of strike, anti-air warfare, and fire support ordnance. The command and decision-making functions will be performed in other joint theater commander assets. Some of the critical technologies involved will include extensive automation to minimize manning, high degrees of passive survivability, flexible information architecture and very robust data links.

In March of last year, the Navy and DARPA jointly initiated the Arsenal Ship Program under the provisions of Public Law 103-160, Section 845. This "Other Agreements Authority" allows unprecedented levels of flexibility and cooperation, while tackling very aggressive schedule and affordability goals. Commercial practices and components are being utilized to the maximum extent possible. Unnecessary government oversight and procedural requirements have been minimized.

With the cooperation of industry, the program is moving as rapidly as promised. Five industry teams performed trade-off studies and developed their initial Arsenal Ship design concepts under

Phase I. On January 10, 1997, three of the industry teams were selected to continue into Phase II, in which they will develop their concept designs into functional designs of the Ship. In January 1998, a single team will be selected to complete its detailed design and construct an Arsenal Ship Demonstrator in Phase III.

At this point I want to emphasize our success in using Section 845 authority in the Arsenal Ship and HAE UAV programs. However, we are rapidly approaching the time when we must determine how to conduct production programs that result from Section 845 prototype efforts. Both the Arsenal Ship and HAE UAV programs will lose many of the benefits derived from the use of commercial practices if the Department does not have the ability to segue into something other than "business as usual" under the Federal Procurement Regulations. This is a important matter that deserves serious thought.

II. Precision Engagement

The second fundamental concept of Joint Vision 2010 is Precision Engagement. It is based on a system of systems that enables our forces to locate the objective or target, provide responsive command and control, generate the desired effect, assess our level of success, and retain the flexibility to re-engage with precision when required. Two DARPA initiatives address this objective: Comprehensive Battlefield Awareness and Real-time, Dynamic Planning, Replanning, and C3 (Command, Control, and Communications).

A. Comprehensive Battlefield Awareness.

To effectively employ precision warfare, field commanders must maintain a comprehensive awareness of the surrounding battlespace and have the ability to exploit that information. In the Comprehensive Battlefield Awareness thrust, DARPA is developing the technologies necessary to translate intelligence data into information useful to the warfighter and to disseminate it to the right place at the right time. This will require complete sensing of the environment, the capability to counter camouflage, concealment, and deception, semi-automated exploitation of wide-area imagery, and birth-to-death tracking of critical moving targets. Once data is gathered, it must be accurately fused and correlated into an integrated, battlefield knowledge-base and disseminated via wideband, direct-broadcast links that allow real-time evaluation, collaboration, and dynamic force management.

At this time I want to mention our use of the Advanced Concept Technology Demonstration (ACTD) as a primary vehicle for transitioning these technologies to the warfighter. Current ACTDs include the Semi-Automated Imagery Processing ACTD, the Battlefield Awareness and Data Dissemination ACTD, and the planned Counter-Camouflage, Concealment and Deception ACTD, which derives from our work in Foliage Penetration Synthetic Aperture Radar. Through the use of these ACTDs — in conjunction with the Services, the Unified Commanders-in-Chief, and agencies such as the Defense Information Systems Agency, the Defense Airborne Reconnaissance Office, and the National Reconnaissance Office — DARPA will put new technology enablers in the hands of the warfighters for immediate feedback and assessment of their operational impact. Each of the efforts described also has a technology base effort supporting future development

The Semi-Automated Imagery Processing (SAIP) ACTD aims to aid image analysts with computerized target recognition algorithms. These cue isolated targets and force structures and allow analysts to exploit high-resolution imagery in a tiny fraction of the time it takes now. The SAIP prototype is currently fully operational. Based on the experiences of Army image analysts, we believe that the Force Status Assessor and Automatic Target Recognition components will be a tremendous aid to analysts in their exploitation work. The transition of SAIP into an operational

exploitation system (the Air Force's Deployable Ground Station) will be a major effort in FY 1998.

The objective of the Battlefield Awareness and Data Dissemination (BADD) ACTD is to demonstrate a prototype information system that delivers a consistent operational picture of joint/coalition forces to warfighters in the battlefield. Commanders will be able to tailor their own presentation from worldwide data repositories (e.g., moving target indicator tracks from Joint STARS, video from a UAV, a one-way whiteboard, video of the commanders' intent, weather data, imagery, and force overlays). In FY 1998, BADD will participate in the US Atlantic Command joint exercise Unified Endeavor to extend information management and dissemination support at the level of individual battalions, ships and wings. Selected applications and dissemination services will be transitioned to the Defense Information Systems Agency for incorporation into the Defense Information Infrastructure Common Operating Environment.

The Counter-Camouflage, Concealment and Deception (CCC&D) program will provide significant enhancement of the military's capability to detect obscured targets hidden under natural and artificial camouflage. We are currently demonstrating real-time detection and cueing of tactical targets under foliage and will begin development of a foliage penetrating Airborne Demonstration Radar.

Detection and classification of moving and stationary targets is the subject of two programs. A next-generation synthetic aperture radar automatic target recognition (ATR) system is being developed in the Moving and Stationary Target Acquisition and Recognition (MSTAR) program. To date, MSTAR has demonstrated specified performance against 10 stationary target types at all imaging aspects over a wide range of sensor depression angles. As the system matures in FY 1998, MSTAR will migrate into the SAIP ACTD system for operational demonstration and transition. The development of computer algorithms for more conventional airborne surveillance radars is the goal of DARPA's Moving Target Exploitation program. Using realistic data being collected now, we plan to perform a real-time Joint STARS demonstration of automated moving target exploitation and a laboratory demonstration of these techniques for a Global Hawk/U-2 platform in FY 1998.

B. Real-time, Dynamic Planning, Replanning, and C3.

DARPA has a number of Planning/C3 efforts which will greatly enhance the ability of the warfighter to manage and exploit the huge amount of data available, to make better decisions based on the filtering and distilling of the data into information, and to communicate the information to each other.

The development of information tools to aid the reduction, filtering and digesting of high volumes of data from broadcast intelligence, multiple sensors, and multiple exploitation sites is the objective of the Dynamic Multi-user Information Fusion (DMIF) program. A series of low-cost applications will be developed to provide "finished" information products to a wide variety of operational systems including applications for targeting, suppression of enemy air defenses, maneuver control, and logistics planning. A prototype is being incrementally deployed and exercised at the Combined Air Operations Center (CAOC) in Vicenza, Italy, and will be incorporated into the BADD overseas exercise in FY 1998.

In the Joint Task Force (JTF) ATD, tools are being built and standards established that enable disparate software applications to be used harmoniously. As a result, system development is accelerated through the "reuse" of building block components. The reuse and enhancement of JTF ATD tools and services will be demonstrated in the Joint Forces Air Component Commander (JFACC) Program. The JFACC Program will develop a command and control system to

revolutionize planning, execution and assessment of future joint air operations through continuous, seamless planning, execution monitoring and replanning for the Air Component Commander.

Last month, the JFACC Program conducted a “proof of concept” warfighter demonstration at the Air Force Command and Control Battle Lab to showcase several prototype system components. All applications were pushing and pulling information from an enriched JTF ATD-developed server suite. The 7-month JFACC effort was achievable due to the reuse of the JTF ATD building blocks. In FY 1998, the program will develop the architecture and building block components for the JFACC Planning, Execution and Assessment System, based on these prototypes. A demonstration of the system will be conducted at the Navy Maritime Battle Lab (USS Coronado). An initial transition of successful components will begin to the Air Force and Navy in the second half of FY 1998.

Last year, Director Lynn described a fieldable, multiband, multimode, programmable communications system called “Speakeasy” that is capable of implementing a wide variety of waveforms on a commercial-off-the-shelf-based open-system hardware architecture. An early demonstration of this capability will occur next month during the Task Force XXI Advanced Warfighter Experiment. DARPA will transition the Speakeasy program to its Service partners (Army and Air Force) in FY 1998. The Services plan to expand Speakeasy's capabilities to include demonstrating wideband data waveforms, complex signals, and software-implemented secure communications.

III. Full Dimensional Protection

Full Dimensional Protection is the term that Joint Vision 2010 uses to refer to control of the battlespace to ensure that our forces can maintain freedom of action during deployment, maneuver and engagement, while providing multi-layered defenses for our forces and facilities at all levels. Two facets of this area are receiving particular attention at DARPA: Information Survivability and Defense Against Biological Warfare.

A. Information Survivability.

As we develop new and powerful ways to collect and process very large amounts of information at extremely high data rates, we must simultaneously look for ways to preserve the security and survivability of our information systems. DARPA’s ongoing information system survivability effort is developing tools to identify information system vulnerabilities, fault-tolerant methods for distributing programs across a network, and new techniques for detecting intruders in large networks. Important results are already at hand. A new approach to ensure fault tolerance for programs moving through networks has been announced by Cornell University. The work solves a critical problem faced by users of Sun's JAVA, Microsoft's ActiveX, and other “mobile-code” technologies. In addition, researchers at the University of California at Davis have developed a system called GrIDS (Graphical Intrusion Detection System) that can detect information attacks on a single component as well as multi-domain attacks, such as worms and coordinated attacks, and can filter out diversionary attacks

This year, the program will demonstrate incident response tools to detect corrupted code and signs of penetration, improve critical networking protocols for enhanced protection, and demonstrate mechanisms for secure interaction of geographically separated applications. Beginning next year and in partnership with the National Security Agency and the Defense Information Systems Agency, DARPA will release a set of reference implementations for secure information routing protocols as well as demonstrate a primitive, survivable "immune system" for responding to attacks and intrusions.

B. Defense Against Biological Warfare.

Today there is a formidable disparity between the magnitude of the biological weapons threat faced by the warfighter and the ability to react to their use by an adversary. DARPA has initiated a biological warfare defense effort to respond to this critical need. The goal of the DARPA Biological Warfare Defense (BWD) Program is to develop and demonstrate those technologies that will minimize the impact of biological weapons (bacteria, virus, toxin and genetically engineered species) on the conduct of US military operations. With funds programmed by DARPA into Office of the Secretary of Defense accounts, and programs fully coordinated with the Assistant to the Secretary of Defense for Nuclear and Chemical and Biological Defense Programs, we are emphasizing the development of real-time warning and "all clear" sensors, immediate medical countermeasures for those already exposed, and information technologies to mitigate and manage the effects of an attack. In the FY 1997 Authorization Act, Congress granted DARPA the authority to budget separately its Biological Warfare Defense efforts for work uniquely focused on the far-term, high-payoff horizon. Accordingly, a separate DARPA Program Element has been established in the FY 1998 President's Budget. Nevertheless, I want to assure the Members of this Committee that all of our efforts remain under the complete purview and scrutiny of the Assistant to the Secretary to preclude duplication and affirm relevance.

Last year we described the "canary-on-a-chip" sensor to warn of the presence of bioagents on the battlefield. As we proceed with our immediate medical countermeasures work, this year I am happy to report recent success at the University of Virginia, where a heteropolymer bound to the red blood cells of monkeys reduced the concentration of a "virus" in the bloodstream by over a million times in less than one hour. In other work, we are investigating engineered T-cells for enhanced immunity.

In FY 1998, we will expand our biosensor efforts to investigate the use of very high sensitivity read-out materials in several types of sensor systems, including gridded array detectors and wick detectors. Our efforts in informatics will also expand to include a full demonstration of a biological warfare "anchor desk" and the development and testing of "software antibodies" to provide the correct treatment protocols. The Marines Corps Chemical/Biological Immediate Response Force will provide an early test of this system.

In the longer term, I anticipate that this program will grow in scope and magnitude to address the many facets of the threat. This is a new and unfamiliar program area for us, and so we are continuing to draw on expert advice from the Defense Science Board and Defense Sciences Research Council. In addition, we have established an advisory group that draws on the pharmaceutical industry and university biological and medical specialists.

IV. Focused Logistics

The fourth functional area described in Joint Vision 2010 is Focused Logistics. It is described as the fusion of information, logistics, and transportation technologies to provide rapid crisis response, track and shift assets, deliver tailored packages and sustainment directly at the strategic, operational, and tactical level of operations. DARPA is aggressively pursing this in its Advanced Logistics Program.

A. Advanced Logistics Program.

DARPA has begun development of advanced information technology to provide rapid crisis response, track and shift assets, and deliver tailored packages and sustainment directly at the strategic, operational, and tactical level of operations. Our goal is to cause a fundamental change in the way logistics planning and operations are conducted today. Through the Advanced Logistics Program, we have taken an end-to-end, systems approach to the military logistics problem, and we

have initiated development of technology within the context of a solid system design and architecture. These technologies support automated generation of logistics plans, seamless interoperability between military and commercial systems, and tools to understand the current logistics situation and predict the supportability of future operations. We believe that this approach is critically important for making next-generation military logistics systems responsive to changing operational needs in crisis situations, while reducing cost and maintaining visibility of all assets. During FY 1998, the program will demonstrate an initial capability to present logistics plans derived from operational requirements. This will provide the first step in automating a previously complex human process.

Technology Push

Joint Vision 2010 calls for vigorous development of advanced technologies. DARPA supports leading-edge technology development in four main thrust areas that are at the foundation of this vision: Information Technologies, Computing and Electronics, Advanced Materials, and Hybrid Technologies. Let me take a moment to describe these technology development areas and some examples of the programs to be undertaken in FY 1998.

I. Information Technologies

The previous discussion of the importance of information gathering and management motivates the dominance of these technologies in our technology-base investment strategy.

A. Understanding

1. *Information Usability*

This program is developing fundamental technologies that allow military operators and analysts to collaborate among themselves and with information systems to solve problems in a distributed information space. The technologies are aimed at augmenting human strengths and compensating for human weaknesses. Among other capabilities, they will enable computers to hear and read — as well as *understand* what they hear and read.

In FY 1998, tools and techniques to filter, access and integrate information from hundreds of disparate, distributed data sources will be developed and tested. Initial automated prototypes to extract information from text and audio information will be tested and baselined against human operator performance. Image understanding technologies for image exploitation, video surveillance and monitoring, and automatic target recognition will be developed and tested to enhance battlefield awareness.

2. *Planning and Decision Aids*

The Planning and Decision Aids technology base program is developing the fundamental technologies necessary to amplify and automate human planning and decision-making capabilities. Key to this thrust is the enhancement of reasoning abilities in situations where the amount of information to be analyzed simultaneously exceeds the ability of an individual human. These programs are essential in today's data-rich environment to provide the commander the ability to sort through a myriad of options and quickly devise decisive strategies to achieve critical goals.

3. *Intelligence Integration*

When I described earlier DARPA's Advanced Logistics Program , the Joint Task Force ATD, the Battlefield Awareness and Data Dissemination ACTD, and the Bosnia Command and Control Augmentation System, I mentioned that each of them required a vigorous technology base. Much

of that responsibility is focused on the Intelligent Integration of Information (I*3) program, which is developing technology to enable a hundred-fold improvement for human and computer users to search, query, monitor, and update collections of hundreds of dynamically changing, potentially inconsistent, heterogeneous data sources. These data sources include knowledge bases, structured databases, semi-structured documents, and unstructured text and image files. A second objective is to develop, demonstrate, and transition a suite of information integration tools which reduce the cost of developing, maintaining, and evolving these large-scale integrated systems.

The I*3 program has already developed important new methods to integrate information from structured databases assembled from semi-structured documents, compensate for missing or damaged data during integration, monitor changes in heterogeneous data sources, automatically relax/restrict user's queries for faster retrieval, and coordinate the actions of heterogeneous information agents. This technology has been successfully demonstrated to significantly improve logistics planning, battlefield awareness and data dissemination, and law enforcement.

4. *High Definition Systems*

Getting information out of machines and into the heads of planners and decision-makers has been a critical problem for some time. DARPA's long standing High Definition Systems (HDS) Program is developing leading-edge display system technology to meet diverse DoD needs for lower power, lighter weight, improved resolution and better user interfaces. The program will demonstrate the feasibility of new display concepts and demonstrate and develop these technologies in systems that satisfy specific military requirements. This year we will demonstrate early prototypes of several flat panel and projection displays using liquid crystal, electroluminescent, plasma, and field emission technologies. We will continue development in novel patterning, film deposition and annealing, and field emission display materials and assembly tools, as well as reflective liquid crystals.

In FY 1998, we will continue ongoing developmental efforts, particularly in those areas in which commercial technologies are not likely to serve military needs. This is especially true in mobile display systems, instrument/cockpit displays, tactical workstations, and large screen displays, and where the viewing environment is hostile (bright sunlight) and in other applications where extreme miniaturization and ruggedness are required. We will also continue development of critical supporting technologies such as phosphors and improved processing tools and techniques. Through DARPA leadership, the US display manufacturing capability has become much more viable. As a result, we believe that our proper role should be much more modest and concentrated on fundamental research and targeted military applications.

B. Dissemination

1. *High Speed Networks*

The goal of the Large, High-Speed Network Program is to develop network technologies that allow rapid and dependable creation, reconfiguration, and deployment of new networking military capabilities, procedures, and management components. The capabilities to be achieved will include high performance, reliable delivery of multiple (multicast) transmissions, and rapid injection of new protocols into operating systems without disruption. While much capability can be obtained from the commercial sector, the military has unique requirements that it must develop, such as networks with all-mobile nodes, and very high (burst) data rate for transmission of high-resolution imagery directly to the battlefield.

During 1998, a new networking technology involving "active networks" and "smart packets" will be tested in an initial implementation. This technology has the potential to reduce the time it takes an operator to reconfigure a network or change its protocol structure. Today this requires many

months or longer, and, therefore, is not possible during deployment or an ongoing military mission. With the new technology, an operator would be able to adapt an entire network within minutes to circumvent a fault, thwart an information attack or meet a crisis need.

2. *Next-Generation Internet*

Internet technology (packet switching), first demonstrated by DARPA in the 1970s ARPANET, is the foundation of today's military and commercial network systems. Virtually all networking systems use this technology, which has become the basis of a multibillion dollar industry.

The Next -Generation Internet program is a new, multi-agency initiative to make major advances in tomorrow's Internet technology. It has three elements: first, to significantly increase networking speeds by 10 to 1000 times; second, to apply and extend research to provide the guaranteed performance in networks that is not possible with today's technology; and third, to enable a new generation of applications based on significantly more capable networks. Other participating agencies, including the Department of Energy, the National Aeronautics and Space Administration, and the National Science Foundation, will concentrate on near-term additions to Internet capabilities.

In FY 1998, DARPA's efforts, in keeping with the high-end needs of the DoD, will be aimed at the long-term, ultra high performance elements of this initiative. Part of our strategy is to build on the successes of the DARPA Broadband Infrastructure Technology (BIT) program, where 40 billion bit per second, multiple wavelength division multiplexing and cross connect switching is being developed and demonstrated. This technology, as well as the prototype technologies being developed in the Networking and Computing programs, will then be applied and integrated into a ultra high speed Next Generation Internet testbed where we will develop and test technologies needed to operate at performance levels 1000 times greater than that available today.

3. *Holographic Storage — Automatic Target Recognition*

Storage of data is a huge problem that must be solved if the DoD is to realize the full-spectrum dominance of Joint Vision 2010. We are meeting this challenge through the development of a new technology in which data is densely stored in the form of an image in a transparent crystal. Recently, under DARPA’s aegis, IBM has demonstrated a record data transfer rate of one gigabit (one billion bits) per second from an experimental holographic data storage system. Although the data density is very high, the most important feature of this technology is the ability to retrieve data instantly using light. Other technologies like magnetic or optical tape require long search times that are unworkable for weapon applications such as Automatic Target Recognition (ATR).

ATR is a very difficult problem and requires more than high-volume data storage. It also requires order-of-magnitude increases in data processing well beyond current or foreseeable hardware. But new mathematics, called wavelets, may form part of the solution. Using wavelet-based algorithms in the Army’s Longbow Fire Control Radar System, we have achieved a dramatic reduction in the processing required to perform target classification with increased accuracy.

II. Computing and Electronics

Advanced efforts in computers and microelectronics are focused on technologies that enable engineered microsystems to both perceive and control the battlefield environment. Advances in these microsystems will increasingly be paced by electronics that do more than just compute, including: high-power electronics for controlling and conditioning megawatts of electrical power; radio-frequency electronics for single-chip, mobile communication; and microelectromechanical systems technologies that merge sensing and actuation with computing and communication.

Investments in advanced electronics are focused in four thrust areas: Sense and Action Amplifiers for the Warfighter, Battlespace Information Channels and Connectivity, Large-Scale Integration of Multi-Technology Systems, and Exploratory Device and Fabrication Technologies. Supporting activities in advanced materials, electronic design aids, and the development of tools and processes for flexible and affordable manufacturing will accelerate DoD's incorporation of emerging advanced electronics technologies into existing and planned weapons systems.

A. Information Processing

1. *High Performance Computing*

The High Performance Computing Program is completing its efforts on scaleable massively parallel systems and is exploring new adaptive computational architectures. For adaptive computing, the goal is to demonstrate a factor of 100 increase in performance when compared to conventional systems by developing new forms of "agile" computer architectures that can configure their hardware to specific military problems, even as these problems arise. The computing technologies developed by the program will be demonstrated for military applications where small size, weight, power, real-time and fault-tolerant performance are important.

This year, we are developing the advanced multicast services needed to support distributed simulation and demonstrating an extensible, modular operating system framework that will be capable of supporting the rigid demands of real-time, fault-tolerant operations for defense missions. In FY 1998, we plan to complete software development environments for scaleable systems and produce prototypes of the component technology. We will validate the technology concepts by emulating the subsystems in an overall system simulation. These embedded technology components will be inserted into testbed systems for command and control, missile avionics and unmanned underwater vehicles.

2. *Optoelectronics*

Optoelectronics — the use of light instead of electricity — is, today, where electronics was in the late 1950s. That is, only a few optoelectronic devices can be integrated together in a circuit. But the recent breakthrough invention of a new type of laser emitter device called the Vertical Cavity Surface Emitting Laser (VCSEL) by DARPA promises to make Very Large Scale Integrated photonics (where tens of thousands of optoelectronic devices are integrated with silicon) feasible, reducing the volume and power of signal and image processors by as much as 1000. This means that critical processing functions that previously had to be performed on large aircraft or on the ground could be performed on a UAV or mobile platform.

In FY 1998, we plan to demonstrate the feasibility of smart pixel arrays (monolithic integration of small arrays of VCSELs and detectors with electronics) for a high-performance, three-dimensional-based optoelectronic signal processor for military battlefield information processing.

3. *Bandwidth Compression*

When data is transmitted by radio, the rate of transmission is severely limited by the laws of physics. And in many cases, no alternative to radio is possible. In these cases it is very important to "compress" information prior to transmission to gain the required speed. During early FY 1997 and early FY 1998, DARPA's Intelligent Bandwidth Compression (IBC) program is developing and demonstrating on U-2 aircraft data, new data compression techniques for complex synthetic aperture radar (SAR) imagery and for contextual background detected SAR imagery. This technology, combined with real-time area of interest detection algorithms, will provide the basis for a operational IBC demonstration with the U-2 or Global Hawk platforms in FY 1998.

B. Components and Devices

1. *Advanced Lithography*

The reduction of size and weight of conventional microelectronic systems depends on pushing the limits of their fabrication techniques, especially lithography. Given the prosperity and robustness of the semiconductor industry, DARPA's long-standing program in lithography can now concentrate on a longer-term profile. Beginning in FY 1998, the lithography program will greatly reduce its emphasis on near-term manufacturing and focus on technologies for the creation of microelectronic patterns 25 times more dense than current state-of-the-art. Innovative research is planned in pattern generation and transfer, imaging materials, new processes, and measurement techniques to provide alternatives beyond current evolutionary trends. We will explore several approaches to advanced lithography, most notably maskless lithography, which would lead to cost-effective manufacturing of the low-volume requirements typical of military systems, as well as reduce new product development time and costs.

2. *Advanced Packaging*

Advanced packaging technology for integrated circuits is an area of strategic importance to the DoD, allowing systems to fully exploit the capabilities of electronics. DARPA's ongoing packaging program has enabled the DoD to have early access to leading-edge technologies, at low production volume. DARPA's Advanced Packaging Program for developing multi-chip module (MCM) technology approaches for digital applications has been highly successful and has now been embraced by commercial industry. That, of course, makes it immediately available for defense. DARPA is now moving into packaging technologies which promise both greater integration density and mixed-signal applications. Research into technologies for greater integration density will investigate approaches that can cost-effectively provide orders of magnitude more computational processing per unit volume or per unit area.

In FY 1998, we will complete projects that will establish a self-sustaining merchant MCM industry accessible by DoD systems designers. We also plan to develop technologies that lead to a ten-fold increase in performance per unit volume for self-contained high-performance digital and mixed-signal microelectronic systems without any increase in total cost of ownership. Finally, we plan to reduce total non-recurring engineering costs by another factor of ten and enable first-pass success on design and fabrication of new MCMs.

III. Advanced Materials

The overarching goal of the Advanced Materials Program is to develop novel materials, materials processing techniques, fabrication strategies, and mathematical modeling for (1) lightweight/high-strength structures, (2) "smart" structures, and (3) structures that have important new electronic, magnetic, or optical properties, and (4) high energy-density power sources.

One of the major thrusts in DARPA's Structural Materials program is the development of free-form, solid fabrication techniques which permit the design and fabrication of complicated components directly from computer models, saving costly tooling and reducing the time to produce parts from weeks to hours. DARPA is also developing ultra-lightweight materials for use in aircraft and missiles which will replace expensive, hard-to-repair honeycomb structures, as well as working with the Army to exploit new materials and new design paradigms to dramatically improve the effectiveness and reduce the weight of soldier body armor.

A new program in the design and development of mesoscopic machines will demonstrate the capability to build devices of interest to DoD at sizes ranging from the size of a sugar cube to that of a human fist. Examples of such devices include air samplers for chemical, biological and

explosive detection, thermal management systems for individual soldiers, turbine engines for micro air vehicles, and compact, portable power systems.

DARPA continues to be the DoD leader in the development and demonstration of Smart Materials. These are materials that can rapidly change their shape in response to their environment. Recent wind tunnel tests have shown the potential for reducing drag nearly 10 percent in an "adaptive" F-18 wing. Smart materials are also being demonstrated as a way to damp the acoustic signal from the structure of submarines and to reduce the insidious vibration from helicopter rotor blades. A primary focus of our work in FY 1998 is in efforts to significantly improve the actuators which form the basis of these smart materials.

DARPA is making significant investments in Functional Materials and devices aimed at making improvements to Defense communication, information and sensing systems. One such thrust is in magnetic materials, where DARPA is developing high sensitivity magnetic field sensors and non-volatile, radiation-hard magnetic memories with very high density, short access times, and low power. In addition, frequency-agile materials based on ferrite and ferroelectric oxides will be developed for tuned filters, oscillators and programmable antennas. Finally, DARPA is developing a new class of infrared materials, infrared artificial dielectrics, that can be engineered to emit and absorb light selectively in different spectral bands. These materials will be very useful in developing infrared camouflage concepts.

The warfighter of the future will be increasingly dependent on electrical systems, and DARPA is developing technologies that enable electronic systems to be more energy efficient. But at the sametime, the warfighter must have improved high energy-density power sources to supply needed electrical power. The goal of the DARPA High Energy-Density Power Program is to develop and demonstrate replacement power sources for numerous military applications. One effort, being run in collaboration with the Army Research Office, has demonstrated a prototype fuel cell designed to replace, in many applications, a popular military standard battery. The target application is the Army's BA-5590 primary (i.e., use-once-and-dispose) lithium battery (the Army purchases approximately 350,000 of these batteries every year at a cost of approximately $100 per battery, including almost $30 per battery for disposal). These new fuel cells, on the other hand, are not thrown away after each use but can be reused hundreds of times. Mission weight savings of factors of 10 or more are projected. The prototype fuel cell, which has the same size and delivers the same power as a battery, has been tested in all orientations and under simulated adverse weather conditions, and was enthusiastically received by Army senior management. We plan future field trials.

In the future, DARPA is developing even higher energy-density power systems based on a number of novel concepts including the direct oxidation of methanol as a fuel, the development of micro (centimeter-sized) turbines, and thermophotovoltaics. Ultimately, one would like to be able to "harvest" energy from the environment so that one would never need to replace a battery. DARPA is exploring concepts in this area as well, as discussed below.

IV. Hybrid Technologies

Technology Push focuses on the identification of key technologies which are believed to have strong potential for military applications. DARPA is investing in several basic technology development projects that offer tremendous potential — even revolutionary — benefit to the military Services. Consider, for instance, developing the technology that enables the warfighter to derive his operational energy requirements from his environment, moving beyond today's solar and wind power, and into, perhaps, the energy plants derive from photosynthesis. This would obviate the need for batteries. By judiciously withdrawing energy where it has been "banked" over time from low-level sources available environmentally, one moves quickly to a revolutionary vision of warfare. This is clearly out of reach today, but the long-term military benefits warrant its

exploration. DARPA will pursue the technologies which might enable this and other such visionary capabilities.

A. Microelectromechanical Systems (MEMS)

Using the fabrication processes and materials of microelectronics as a basis, MEMS technologies construct tiny mechanical devices and couple them to electrical sensors and actuators. Mechanical components in MEMS, like transistors in microelectronics, have dimensions that are measured in microns and number from a few to millions. MEMS is not about any single application or device, nor is it defined by a single fabrication process or limited to a few materials. More than anything else, MEMS is an approach to fabrication that puts a large class of electromechanical systems on the same cost-performance trajectory that microelectronics systems have followed over the last four decades.

MEMS embedded into weapons systems, ranging from smart munitions and radio-frequency systems to high-maneuverability aircraft and chemical laboratories on a chip, will bring to the military new levels of situational awareness, precision strike capability, and weapons performance. These heightened capabilities will translate directly into tactical and strategic military advantage, saved lives, and reduced materiel loss. While MEMS devices will be a relatively small fraction of the cost, size and weight of these systems, MEMS will be critical to their operation, reliability and affordability. MEMS devices, and the smart, functional products they enable, will increasingly be the performance differentiator for both defense and commercial systems.

B. Electronic Dog's Nose

In another example of a visionary effort, we are starting to develop an "electronic dog's nose."

Most current approaches to the detection of mines and unexploded ordnance use sensors that measure physical properties associated with the threat. Infrared and electro-optical techniques, ground penetrating radar techniques, induction coils, and magnetometers have all been tried for locating the metal and plastic associated with mines and unexploded ordnance. But these types of sensors suffer from large false alarm rates even at modest detection probabilities.

Canines, on the other hand, are one of the most effective means of mine detection used today since they actually smell the presence of explosives. Despite their effectiveness, there are severe limitations associated with their use: the logistics requirements are extensive, their work periods can be as short as 30 minutes under adverse conditions, and experienced handlers are often not able to tell when a temporary medical condition has degraded the dog's olfactory capacity. In DARPA's land mine and unexploded ordnance detection program, we seek to develop the electronic analog of a dog's nose.

Traditional chemical sensing techniques focus on the detection of individual chemicals. The mammalian nose, on the other hand, is capable of identifying complex "odors." Humans, for example, do not identify specific chemicals when they whiff the aroma of red wine, but assign a "smell" to the hundreds of chemicals detected. The electronic dog's nose program utilizes the mammalian olfaction chemical sensing paradigm, i.e., we trade individual chemical identification for "odor" identification. This affords distinct advantages in sensing speed, specificity, and sensitivity. This year, the program is developing initial prototypes.

C. Micro Air Vehicles (MAVs)

Micro Air Vehicles are at least 10 times smaller than current flying systems (i.e., less than 15 centimeter in any dimension) and have the potential of providing unprecedented situational awareness for Small Unit Operations. Future Small Unit Operations and operations in emerging

warfighting environments such as urban scenarios (where there is a dense civilian population component and, therefore, a high probability of fratricide) require unprecedented capability for local situational awareness and threat avoidance beyond the unit's line-of-sight. Users want real-time situational information from mobile, controllable sensor systems. MAVs eliminate the latency associated with reconnaissance from higher-altitude assets. Emerging technological advances in miniature, highly integrated electronic and electromechanical systems provide an opportunity to create a new class of air vehicles with overall size and mobility approaching that of hummingbirds.

The technical objectives of DARPA's MAV program are (1) to develop technologies that enable controlled flight of extremely small air vehicles, and (2) to develop MAVs capable of performing useful military missions at an affordable cost. With baseline technology integration assessments, design studies, and operational scenario assessments underway in FY 1997, FY 1998 plans call for initial design and development of functionally diverse unpropelled and propelled MAV systems that employ different technology solutions and that satisfy user-identified critical military applications. Exploration and feasibility demonstration of key flight-enabling technology components will also take place.

New Ways of Doing Business

Beyond its traditional science and technology focus, DARPA has taken the lead in DoD in establishing new ways for the Department to conduct business. I would like to take this opportunity to tell you about one success story and one on-going program.

Two weeks ago, with DARPA sponsorship, the Under Secretary of Defense for Acquisition and Technology signed an agreement with the Environmental Research Institute of Michigan (ERIM) and Intermap Technologies Inc. that broke new ground for the DoD. DoD took a technical capability, developed by ERIM under a DARPA project, and transitioned it from purely military use into dual-use, commercial operation. The government-owned system — the Interferometric Synthetic Aperture Radar - Elevation (IFSARE), which is mounted in an ERIM-owned, Learjet aircraft — will be transferred to ERIM for commercial use.

The IFSARE system has imaged large geographic areas with a high degree of terrain height accuracy, at a cost lower than that permitted by previous methods. It also has the capability to combine information from synthetic aperture radar and digital terrain elevation models to create large, high-quality, digital and photographic maps for the military. Under the agreement, Intermap will take over maintenance and operating costs, and will attempt to sell commercial mapping services. ERIM will bear the cost of operating, maintaining and improving the system, but DoD will retain quick-reaction rights to use the system at preferred rates. Even more innovative, ERIM will pay DoD royalties based on their commercial sales, until DoD is paid back for its development costs.

In a separate, on-going effort, DARPA is teamed with the Services specifically to reduce the cost of tactical missiles through the Affordable Multi-Missile Manufacturing (AM3) program. AM3 is not a technology development program. Rather it is designed to motivate contractors to insert rapid design and prototyping capabilities, flexible manufacturing technologies and modern business practices into ongoing missile programs. The AM3 program is being conducted in three phases and includes all US missile prime contractors and all DoD missiles.

A major program theme is the integrated manufacturing of a mix of missiles with maximum use of common facilities, equipment, and processes. This multi-missile manufacturing capability will compensate for declines in individual missile quantities. Recent consolidation of the tactical missile industry provides a timely opportunity for insertion of AM3 cost reduction concepts.

Phase One of AM3 defined collections of innovative technical and business practice concepts and documented the potential for savings of 25 to 50 percent across the tactical missile portfolio. Phase 2, which is just now concluding, is providing validation of the new AM3 concepts and associated savings in component level and sub-system level design and manufacturing demonstrations. Phase 3 of the program, which requires a 50 percent industry cost share, will competitively select industry participants to perform major implementations and demonstrations of AM3 concepts in on-going missile programs.

The AM3 steering group includes the five tactical missile Program Executive Officers, who are committed to support AM3 demonstrations on their missiles and in subsequent production implementation.

A. Dual Use Applications Program.

The Dual Use Application Program (DUAP) is a joint effort of the three Services and the Office of the Secretary of Defense. Its mission is to develop, test, and then transfer to the Services new approaches to leveraging the commercial sector for DoD's benefit across the entire acquisition spectrum. DUAP will increase the amount of commercial leveraging by the Services and will embed these new ways of doing business in the Services by using them to build a cadre of experienced people. More specifically, DUAP has two thrusts. The first thrust is a Science and Technology Initiative to transfer the relatively mature dual use research and development (R&D) approach to the Services by incentivizing them to carry out dual use R&D projects. The second thrust is a Commercial Operations and Support Savings Initiative (COSSI), whose mission is to develop and test a method to reduce the operations and support costs of the DoD by inserting commercial products and processes into fielded military systems.

DUAP builds on DARPA's historic involvement in leveraging commercial technology, but is different in some key ways.

First, and most obviously, DUAP is a program of transition. It is not sufficient for DARPA to prototype a new dual use approach for DoD. We must also ensure that the approach is transitioned, just as we do for our technologies and military systems. DUAP is managed by a joint Steering Group made up of the military Service Acquisition Executives, their Science and Technology Executives, the Under Secretary of Defense for Acquisition and Technology and other top officials from the Office of the Secretary of Defense. The projects to be funded will be selected and managed by this group.

Secondly, the use of commercial technologies and products to reduce the operations and support costs of fielded systems is clearly a new application of the dual use approach.

B. Acquisition and Prototyping Authority.

Last year, two major studies validated DARPA's work with new acquisition authorities, paving the way for expanded DoD use of these innovative methods. In March 1996, the General Accounting Office reported favorably on DARPA's use of Other Transactions under 10 USC 2371 and the resulting technology developments. In June 1996, an Integrated Product Team led by BG Claude Bolton examined "The Services' Use of 10 USC 2371 'Other Transactions' and 845 Prototype Authorities." The report examined and validated DARPA's use of these acquisition authorities, and recommended their use to the military Services.

Also last year, Congress enacted Section 804 of the National Defense Authorization Act for Fiscal Year 1997, which extended the Section 845 prototype authority for three years and made it available to the Military Departments and other DoD components designated by the Secretary. DARPA is providing assistance and sharing lessons learned with the military Services and DoD

components in conferences and working groups to facilitate the wider use of these innovative acquisition approaches.

We cannot, however, rest on our laurels. I spoke to you earlier about the serious issue that is coming to the forefront as these prototype projects transition into production. I encourage a dialogue between the Department and the Congress to resolve this for the future.

I hope this brief overview has given you a perspective of DARPA's activities and the manner in which the agency supports Joint Vision 2010 through its many military systems and technology development activities. As always, we try to be innovative in our view of military needs and the possibilities new, advanced technologies offer the warfighter. And, certainly not of the least importance, we strive to find ways to get these new capabilities to the warfighter quickly and affordably.

Thank you for the opportunity to meet with you today, and I look forward to your questions.